

The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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The Maintenance of Consumption

THE years 1919-1939 have been described as the two most depressing decades in our history, in which we converted victory into international friction and the recommencement of strife. It is our present aim to ensure that the next two decades shall be years in which we shall convert victory into international prosperity. The basic problem of the years of depression was that of finding work for everyone who desired it. We saw the increasing productivity of the machine displace manual labour to an ever-increasing extent because the machine did not go on strike and was cheaper than manual labour. We have seen automatic machinery controllable by one man do the work of tens or hundreds of men. Our economic system has not kept pace with the age of plenty which is with us now if we did but know how to use it. All these facts have been patent to industrialists and technical men for the last 10 or 15 years, but no one has yet been able to find the key to the problem of how to allow men to buy the increased quantities of goods which the machine renders available.

Some attempt to answer this question was made by Mr. F. L. McDougall, the Economic Adviser to the Government of the Commonwealth of Australia in London, when he dealt in a recent paper to the Royal Society of Arts with "Empire Primary Products in Relation to Post-War Reconstruction." The chemical industry is vitally interested in agriculture because the production of fertilisers of all kinds is one of the principal activities of the industry and in the production of fertilisers more than one branch of the chemical industry is concerned. The four overseas Dominions cover 14 per cent. of the entire land surface of the world but possess only 1.4 per cent. of the world's population. Nevertheless, Canada and Australia together normally export some 45 per cent. of the total amount of wheat entering world trade; Australia, New Zealand and South Africa are jointly responsible for 60 per cent. of the world export trade in wool, for 20 per cent. of the world's imported beef and 80 per cent. of its mutton; while Canada, Australia and New Zealand send to the world's markets 49 per cent. of the total of cheese and Australia and New Zealand together 40 per cent. of the world's imports of butter. The effect of the last war was to cause a great expansion in agriculture throughout the Dominions in order to supply the European countries which were thrown out of production during the war and were in a starving condition after it. As the European countries went back into agricultural production, difficulties were caused in the British Empire and the U.S.A. Much

the same effect can be visualised from this present war. It is a comment on the practice of economic self-sufficiency that while in 1924 wheat was admitted free of duty into Italy and Germany, by 1934 the tariff barriers had been raised to 12s. 4d. in Italy and 18s. 11d. in Germany, far higher than the actual value of the wheat itself.

Nor must it be forgotten that one effect of this war will be to increase greatly the movement that was already well under way in the Dominions to increase industrial production. Mr. McDougall points out that the Dominions will undoubtedly emerge from the war far better equipped for industrial production; the whole instinct of the Dominions and their war-time experience will favour large-scale manufacturing units and high outputs per man employed. The population of the Dominions will not provide adequate markets for such developments; hence export markets must be sought.

Mr. McDougall's analysis leaves no doubt in our minds that this country and the Empire as a whole will have exceedingly difficult problems to face in maintaining industrial prosperity. The solution which he proposes is based upon one of four essential human freedoms laid down by President Roosevelt in his third inaugural address to Congress—freedom from want. In order to retain purchasing power we must maintain expenditure on a vast scale after the war, and he suggested that the nations of the world should devote, say, 5 per cent. of the resources now demanded for the war effort to securing the health and well-being of their own peoples. "In the post-war world," he maintains, "the only way in which the older industrial countries will be able to find adequate markets for their enterprise and skill will be if there is a world-wide movement to improve housing, clothing, transport, and enjoyment of leisure. Manufacturing nations are going to be far more widely diffused throughout the world and the industrial nations must become industrial specialists, relying on their technical abilities for the export of capital goods if they are to retain their position in the forefront of world progress." This is an interesting and important suggestion if applied to such countries as India, Japan, China and elsewhere in the Far East. There are difficulties in applying it directly to industrialised and highly-organised countries such as Great Britain or the U.S.A., but there are vast areas in the world, and in Europe to-day, in which there is immense potential purchasing power to be obtained by raising the standard of living. The problem is still, how is this to be done?

NOTES AND COMMENTS

Concentration of Industry

THE dates limiting the period within which voluntary arrangements for concentration of production could be submitted were announced in the House of Commons on Tuesday by the President of the Board of Trade. These dates scarcely affect the chemical, metallurgical and allied industries, as they are practically all included in Group I of Part II (Protected Establishments) of the Schedule of Reserved Occupations and Protected Work. The group comprises establishments engaged in the following work: metal manufacture, etc.; coke-oven operation, including operation of by-products plant; petroleum refining, etc.; cement manufacture; chemical manufacture; explosive manufacture; fertiliser production; fat processing; glucose production; and yeast manufacture for bakeries. The plastics industry, however, and the linoleum industry are included among those that have to concentrate production around nucleus firms. The latest dates for the submission of voluntary schemes are: for plastics, May 24; for linoleum, May 31. What is actually meant by "plastics" in this connection is the subject of a discussion which still continues.

H₂O for Incendiary Bombs

FACTORY executives are frequently invited by manufacturers of liquids and powders intended for use against incendiary bombs to attend demonstrations of these products. Accompanying advertising matter—besides frequently making exaggerated claims—sometimes includes statements to the effect that tests of the product have been carried out "in the presence of Home Office officials," and other statements are made implying that the product has received official approval. The Ministry of Home Security's recommendation is to use plain water projected by a stirrup pump and this advice is based on long experimental work which shows that an incendiary bomb can, in average circumstances, be dealt with by this method in about fifty seconds. Water has the advantage of costing nothing, an important consideration when it is remembered that the control of the bomb is of minor importance compared with the extinguishing of the fire likely to result from it. These two operations may demand attention simultaneously and the nozzle of the pump is designed for that purpose. The Ministry has tested a large number of specially prepared liquids and powders and has found that in no case did the liquid have any significant advantage over water used with a stirrup pump, or any powder show any such advantage over sand. There is, in fact, no known liquid commercially practical which can be recommended in preference to water. Moreover, some of these preparations emit fumes or dense smokes, which are in some cases poisonous, and in others make the preparation unsuitable for use indoors.

X-Ray Analysis in Industry

X-RAY analysis was first applied to the determination of the atomic arrangement in crystalline structures, and this work has had far-reaching results in many branches of science. More recently, this powerful tool of the physicist has been used to investigate many other characteristics of the solid state such as the identification of crystalline constituents of minute samples, the structure of alloys, the identification of intermediate products in chemical processes, the identification of allotropic changes in refractories, and the determination of sub-microscopic crystal size and orientation. A new field, hardly explored at all as yet, is that of the sub-microscopic structures within each individual crystal, such as occur in age-hardening and other types of imperfect phase precipitation in the solid state. Such structures profoundly influence physical properties and hence are of great interest. The importance of this subject, particularly for the present war effort, has led to a widely expressed desire for closer collaboration and sharing of experience between those concerned with the subject. This desire is being met by the publication of a series of papers invited by Sir Lawrence Bragg, President of the Institute of Physics and a pioneer

in this field. They will be published by the Institute in two special issues of the *Journal of Scientific Instruments* (which Journal is now partly devoted to the applications of physics in industry). The first group of papers will be published in the May issue and will deal with the applications of X-ray methods to a wide range of industrial problems. The second group, which is to appear two or three months later, will deal with the technique of the methods and some recent developments.

Social Service for Chemists

PROFESSOR E. C. C. BALY, addressing the West Riding Section of the Society of Dyers and Colourists recently, said that chemists were particularly fortunate in having organisations which protected both their educational and economic interests. The Institute of Chemistry and the British Association of Chemists each in its sphere adequately dealt with these matters. A recent important development had been that since the compulsory insurance of salaried workers earning less than £420 per annum, the British Association of Chemists had been appointed agent for the administration of this insurance for chemists. This meant that a chemist who was a member of the association could receive unemployment insurance from the association instead of having to attend at the labour exchange. All who wanted to protect the status of the chemist would appreciate this development. He hoped that it might result in a closer working between the Institute of Chemistry and the B.A.C. who were alike interested in improving the status of chemists.

Salvage by Welding

SALVAGE as applied to the national war effort is a subject of many and varied facets. Domestic salvage is an important aspect of the problem, the stimulation of which can be effected by means of verbal propaganda, whether spoken or written. Commercial salvage is of equal importance, but its success or failure depends less on propaganda than on the general efficiency and "general knowledge" of firms concerned. It is probably true by now that most firms engaged in metallurgical work, or metal manufacture of any kind, are conscientiously collecting all their turnings, drillings, and other miscellaneous metal waste, and either re-using the material or handing it over to the local collector of scrap. The same cannot be said, however, of the salvaging of worn tools, dies, and the like. It is a far more economic process, and therefore far more valuable to the national effort, to rehabilitate these tools as tools than to add them to the municipal scrap-heap. The British Oxygen Co., Ltd., in their publication *Industrial Gases*, include some interesting indications of how worn and damaged metal work may be salvaged by welding. Illustrations show how welding may be applied to all kinds of apparatus, from a garden fork to a gear-box. Apart altogether from the national aspect, two important considerations come into play: economy, and dire necessity. The cost of repair by welding as a rule is many times less than the cost of replacement; in one instance quoted a repair was effected at the expense of a few shillings to a piece of apparatus which would have cost £17 to replace. Where dire necessity comes in is when it becomes impossible to procure spare parts except after long delay. As far as metal is concerned, welding provides a very satisfactory as well as a patriotic answer to the question of restriction of supplies.

Abietic Acid Esters

IMPROVED fluidity, flexibility, and impact resistance of asphalt, and increased speed of penetration into felt, paper, asbestos, and cellulose materials can be obtained through the use of liquid esters of abietic acid, according to tests completed by the Hercules Powder Co., Wilmington, Delaware. Properties which these solvents impart to asphalts indicate that increased adhesion between asphalt and stone and gravel used in road construction will result. The materials markedly lower the viscosity of a blown asphalt at temperatures above its melting point. The effect on viscosity is far greater than the reduction in melting point.

Judging Coal on its Proximate Analysis

A Problem for the Works Chemist

by "CHEMYST"

MOST works buy greater or less quantities of coal for use either for steel raising processes or for their own particular purposes. This coal, in chemical works, is generally used for generating heat either in the boiler or in furnaces and chemists and engineers are therefore called upon to advise the buying department as to the type of coal that should be procured. Many examples can be quoted of failure to detect, in the laboratory, combustion characteristics that have caused the coal finally purchased to yield inferior results. Consequently, there has been speculation upon the value of the tests usually employed, and particularly of those which come under the general description of "proximate analysis."

The proximate analysis of coal involves a determination of its moisture content, its volatile matter and "fixed carbon" content, and its ash content. As is well known, the ash content is obtained by burning a gram of coal to ash in a muffle furnace, and the volatile matter is determined by heating a gram of coal in a crucible under carefully standardised conditions to a temperature of 925°C. The "fixed carbon" is obtained by subtracting the ash and volatile matter from 100. In practice it is desirable to do two moisture tests, of which one is the moisture in the coal as received, and the second is the moisture in the air-dried sample. The latter can be conveniently obtained by spreading out the coal in a thin layer in a room at atmospheric temperature overnight. A typical result may be as follows: moisture in coals received, 10 per cent.; moisture in air-dried coal, 1.8 per cent.; volatile matter, 32 per cent.; ash, 8 per cent.; fixed carbon, 60 per cent. The problem is, given the results of such a test, can the combustion characteristics of the coal be determined, and if so, how?

Interpretation of Results

This question has been examined by Mr. J. G. Bennett, Director of the British Coal Utilisation Research Association, in a recent paper to the Institute of Fuel. Mr. Bennett's conclusion is that the proximate analysis of the coal does not enable its combustion characteristics to be determined, in spite of the great deal of work that has been expended upon devising accurate methods for conducting it; and he maintains that while we have, in recent years, put a great deal of work into the improvement of analytical methods we should ask ourselves more about the interpretation of the results, and in future we ought to turn our attention to the development of small scale combustion tests which will permit a rational classification of fuels in terms of their actual performance.

This conclusion was not wholly confirmed by the discussion on the paper, and this account is based upon conclusions derived from the paper and discussion combined. Mr. Bennett's analysis was devoted largely to the examination of the volatile matter content of the coal as disclosed during the proximate analysis and with its physical and chemical characteristics as disclosed by special tests, which have been built up as a result of research work conducted on coals during the last 20 years. This includes the work of Seyler, Foxwell's plastic curve, the Sheffield swelling test, the Woodall-Duckham swelling test, and so forth. Mr. Bennett's general conclusion was that the volatile matter content of the coal did not indicate what would be its properties as disclosed by any of these special tests. This conclusion, however, did not meet with general agreement.

The conditions in a furnace should be recognised before attempting any interpretation of the proximate analysis in terms of the behaviour of the coal. It can be imagined, in the first place, that a furnace bed consists of a bottom layer of more or less completely burnt ash, a layer of coke or semi-coke above this, and, on the top of the furnace bed, a layer of fresh coal. Air passes through the fuel bed from the bottom

and the heat generated by combustion distils the coal, generating tar and gas in the space above the furnace. According to the rank of the coal and its volatile matter content, there will be more or less volatile matter to be burnt. The conditions for this are: first, an adequate supply of air admitted above the fuel bed; and secondly, an adequate temperature so that combustion may be completed. Unless air flows freely up through the fuel bed, the coal cannot be distilled. Passage of air may be prevented by the formation of viscous slag in the ash zone or by the formation of a plastic layer in the coal. The plastic layer forms in coking coals generally at temperatures between 380°C and 420°C and disappears at temperatures between 440°C and 520°C; the lower the volatile matter content of the coal the later is the plastic range in starting and finishing.

Zones of the Fuel Bed

When the coal is burnt on a travelling grate stoker, the fuel bed can be divided into three zones depending not upon the depth of the fuel bed, but upon the distance from the furnace door in a horizontal plane. These are: (1) The front or ignition zone. Here ignition starts on the surface of the coal, when it has been raised by radiation to its temperature of ignition, and travels down the bed. Considerable unburnt volatile matter is given off. The process of distillation of the volatile matter also causes carbonisation of the coal and a carbonisation zone will always be a little below the upper combustion zone or ignition plane. (2) The middle or combustion zone, where the main mass of fuel is burnt, and where considerable CO is formed by secondary reaction of CO₂ with incandescent fuel. (3) The back or burning-off zone, where the bed becomes thin and residual carbon is burnt off from the ash and clinker. Here excess air passes through the bed.

In the middle zone there will be a mixture of semi-coke and plastic coal still carbonising which may prevent flow of air through the fuel bed. Below zone 3, air may be cut off by clinker formation. It is, therefore, clear that what is required to be known about coal is some estimate of its probable calorific value, a picture of its behaviour during distillation in the extent to which it is likely to become plastic and thus prevent the flow of air through the fuel bed, and finally the extent to which it is likely to form clinker. The problem to be decided is whether and how, by interpretation of the proximate analysis, a works chemist can get an intelligent picture of the behaviour of these characteristics of the coal.

The total moisture content of a coal is not of any great significance except that if the coal is regularly to leave the colliery in a wet state the consumer will be paying for water. Moisture has an adverse effect on the efficiency of a furnace because for a given exit flue gas temperature of 160°C, each 1 per cent. of moisture represents a loss of efficiency of 0.1 per cent.

The moisture in the air-dried coal is a highly significant figure. Experience has shown that high rank coals generally contain but little moisture of this character. In and below the coking range the moisture content of the air-dried coal increases with decreasing coking power. If a coal possesses coking power it will become plastic in the furnace. As a broad generalisation good coking coals will contain less than 2 per cent. of moisture on the air-dried sample, while a non-coking coal will generally contain more than 6 or 7 per cent. This fact reinforces Mr. Bennett's pleas for more work to be done in the interpretation of results.

From the volatile matter content of the coal it can be inferred in a general way whether a coal is an anthracite, a low volatile smokeless coal, a coking coal, a gas coal, a high volatile steam coal, and so forth, and this test coupled with the moisture in the air-dried sample will give reasonable cer-

tainty to the deductions. This information, coupled with the ash content of the coal, will enable a good estimate to be made of the probable calorific value. Starting with the lower volatile anthracites, the calorific value will drop slightly into the smokeless low volatile steam coal range, and will then remain fairly constant over a wide range of coals until the volatile matter content reaches about 30 per cent., after which, as the rank of the coal diminishes, the calorific value will decrease with increasing volatile matter owing to the rising oxygen content of the lower rank coals.

If to the figures given in the proximate analysis the chemist would add his observations of the type of coke button produced in a volatile matter test and the colour of the ash, an intelligent and experienced fuel chemist can deduce with considerable accuracy a great deal concerning the properties of the coal with which he is dealing. It is also a question of interpretation.

Finally it must be pointed out for the benefit of those who are not fuel chemists, that the methods of coal analysis are now laid down in British Standards Specifications so that all should be able to carry out the tests with equally accurate results, given a little practice and experience.

A Typical Instance

As a specific instance of interpretation, suppose the works chemist is given an unknown coal on which to express an opinion, and he has nothing to aid him beyond the apparatus for conducting a proximate analysis. He finds that the coal contains (on the dry basis) 7 per cent. ash. He concludes that it is reasonably well-washed coal, almost a little cleaner than is usual or necessary for boiler purposes. He then finds that the moisture content is 9 per cent. This implies that his company is paying a good deal for water, and that the coal should have been drained better. It will certainly have left the colliery very wet, or have become so during transit. On the air-dried sample the moisture is 2.5 per cent. He will suspect that this may be a coking coal, probably a gas coal, and may give trouble owing to plasticity. A crucible test on the dry sample discloses 34 per cent. volatile matter. The "button" of char in the crucible is hard but not much swollen. The inference is that it is still a gas coal, but one that does not become intensely plastic, and should thus give only a moderate amount of difficulty from plasticity under heat. The calorific value of the coal will be decreased by its water content, but on the air-dried sample it will be high. This should be a coal high in hydrogen, and but just on the border-line of coals high in oxygen. It can thus be considered a coal of good calorific value, provided that a lower moisture content can be secured at the colliery. Finally, the colour of the ash will be noted. If this is red, that taken in conjunction with the obvious plasticity will cause the coal to be rejected for boiler or furnace work; if the ash is white, it can be inferred that the ash will probably not be fusible, and the coal may well be accepted.

Chemicals in South Africa

Research on Fish Liver Oil

FISHING interests in Cape Town have decided to make an annual grant of £500 for four years to enable the Department of Chemistry at the University of Cape Town to carry out research work on South African fish oils, with special reference to the therapeutic properties of fish liver oils. At the end of 1943 the position will be reviewed and the question of continuing the grant will be considered. At the graduation ceremony in June the degree of doctor of philosophy was conferred for a thesis on the vitamin A content of South African fish liver oils.

The possibility of extracting oil from the liver of the grey shark is being investigated by Mr. W. Tayler, of the University of Cape Town, who is collecting 150 shark livers at Gansbaai. During the winter grey sharks are found in thousands in the shallow waters of the harbour, where they feed on small fish and fish offal. They are harmless and

provide good sport for rock anglers. The fish necessary for the experiment are being caught by professional fishermen. If the experiments prove successful the extraction of oil will become an important branch of the fishing industry. This experiment is distinct from that mentioned above.

Wattle Trade Expansion

The war has had a stimulating effect on the wattle trade. During 1939-40 some 97,935 tons of wattle bark and 41,237 tons of wattle extract were exported with an aggregate value of about £1,307,000, as compared with a total export value of bark and extract of £908,000 the previous year. These figures are the highest so far attained by the wattle industry, and appreciably exceed those for the peak years of 1922, 1925 and 1927. This increase is attributed to the large increase both in the quantities exported and the price realised. Since the outbreak of war the price of wattle bark has been raised by 10s. a ton and that of extract by £1 a ton. This is offset by the higher prices of wire, freight, labour, etc., but none the less some increased benefit does accrue to the grower. During the first six months of war, exports of wattle bark or its equivalent exceeded those of the corresponding period of the previous year by about 23 per cent.

Oil Refining Position

In a comprehensive review of the year's operations of the South African Torbanite Mining and Refining Co., Ltd., at the annual meeting on December 9, the chairman said that for the expansion of the industry they were dependent on the fiscal rates on imported petrol and on importations of crude oil. When the company was formed and based on the then existing rates of customs and rail freight, these fundamentals were laid down and accepted as the basic economy on which the company could exist. These fundamentals were completely altered when the Government reduced the price of imported petrol by lowering the customs and rail rates, and though the Government had endeavoured to compensate the company for this change, the full loss had not been made good. He set out the present arrangements with the Government for the production of oil, covering a period of five years. He stated that the Government was unwilling to lay down any longer-term policy, without which the company could not plan to develop or extend beyond the present scale of operations. The Government still fears a heavy loss on revenue through decreased petrol imports if it gives too much encouragement to the refining of imported crude oil.

Midland Chemists' Association

Luncheon at Birmingham

ONE hundred members of the Midland Chemists' Association, which comprises the various chemistry organisations in that area, lunched at the Midland Hotel, Birmingham, recently, under the chairmanship of Mr. A. Churchman. The guests included the Lord Mayor of Birmingham, Alderman W. Martineau, and the Lady Mayoress; also Sir Robert Pickard, Director of the Cotton Research Association, who was representing the President of the Institute of Chemistry.

Proposing the toast of "The City of Birmingham," Sir Robert Pickard referred to the great contribution made by Birmingham to modern chemistry, alluding in particular to the important pioneer work of Professor Tilden, Professor Frankland, and Professor Morgan, of the University of Birmingham. He added that the traditions set up by those gentlemen were being worthily maintained by the present Professor of Chemistry at the university.

The Lord Mayor, in the course of his reply, commented on the fact that since the Great War industrialists in Birmingham and elsewhere had realised more fully the importance of research in order to make business successful.

The toast of "The Guests" was proposed by the chairman and responded to by Mr. Austin Lowe, chairman of the Plastics Group of the Society of Chemical Industry.

By-Product Recovery from U.S. Coal

Production of Naphthalene and Toluol

THERE is always something to be learnt from the experiences of others dealing with familiar problems; and a description of the economic and chemical engineering aspects of by-product recovery from coal in the United States, by J. Gordon Sweeney, assistant chief chemist of the Brooklyn Union Gas Company, New York, contains many points of interest. His original paper was published in the *Gas Age* (March 13, 1941, pp. 27-29).

The recovery of naphthalene, pyridine, cyanogen, sulphur, and phenol, is fully dealt with in the paper, as well as the stock by-products—tar, sulphate of ammonia, and light oil (benzol, toluol, xylol)—and it is Mr. Sweeney's remarks on some of the "minor" by-products that are particularly suggestive.

Naphthalene, as he points out, leads to many distribution problems from a gas operator's point of view. In his company's Greenpoint coke-oven plant a very considerable amount of naphthalene is obtained from coal carbonisation. Until about four years ago most of it was recovered in the tar and disposed of at tar value. Since that time, the market demand for naphthalene has paid them to recover part of it so that it can be shipped separately. This is done by first skimming the floating solid material from the sump water following the final cooling. At this stage the naphthalene contains about 60 to 70 per cent. water. By melting and recrystallising and by keeping it in liquid condition most of the water is removed. Thus when ready for sale it is almost water free and is loaded by pumping it, as an oil, into large insulated tank trucks. These carriers convey the crude material to the refinery where it is converted into white crystalline naphthalene. The yearly production of crude saleable material is about 500,000 lb. and its value is about three times that of tar.

Pyridine Recovery

During the last year or two pyridine has been very much in the public eye on account of the phenomenal cures of pneumonia made by its derivative, sulphapyridine. The total amount of pyridine, however, required for medicinal purposes is small. Also a large share of what is called pyridine in the coke-oven gas consists of other tar bases known as picolines or methylpyridines. These picolines resemble pyridine in structure and properties and are suitable for the main use of pyridine, which is as a denaturant for alcohol. Pyridine has long been known in coke-oven gas but until recently the cost of apparatus necessary to remove it was uneconomical for most by-product plants.

To understand the recovery of pyridine one should remember that it is a basic substance and reacts with acids in somewhat the same way as ammonia. As the gas containing both ammonia and pyridine is made to bubble through the dilute sulphuric acid solution in the ammonium sulphate saturators, the acid reacts with both basic materials, forming ammonium sulphate and pyridine sulphate. If no attempt is made to recover the pyridine, most of it is retained by the saturators until a concentration of about 4 or 5 per cent. is reached. After that the pyridine either remains in the gas or some of it contaminates the sulphate of ammonia which is produced as crystals. The continuous recovery process at Greenpoint aims at removing the pyridine continuously from the saturator bath, so that it reaches only a low concentration in the bath, when most of it is retained with the ammonia. Production at present runs between 30 and 40 gallons a day.

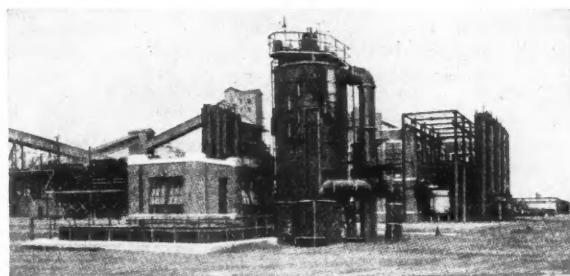
Hydrocyanic Acid

Hydrocyanic acid—HCN, as it is commonly called—has long been an objectionable impurity in coal gas, but fortunately, at Greenpoint Works, the dry oxide purifiers, with the help of a small amount of ammonia in the gas, are able to remove all but about two to three grains of HCN per 100

cubic feet. With removal as complete as this, extra expense for additional apparatus would not be justified unless the returns from the cyanogen recovered would show a profit. For many years the recovery of cyanogen from coal gas was not financially attractive, but since the price of gold was increased in 1933 the demand for cyanides, used in the refining of gold, has increased and certain by-product plants have found it profitable to instal recovery plants.

Toluol for the Defence Programme

In conclusion Mr. Sweeney made certain observations concerning the relation of toluol to national defence. The United



By-product house at Greenpoint works, showing naphthalene scrubber and outdoor saturators

States defence programme, he notes, may call for increased consumption of phenol for the manufacture of picric acid for high explosive purposes. The probabilities are, however, that it will not be used for munitions because of its instability. It is much safer to handle trinitrotoluol and, unless there is a real shortage of this material, the production of picric acid on a large scale seems remote.

Considerable space in the technical journals has been given to reports that the oil industry will be a large producer of toluol. Oil cracking has been perfected to such a degree that toluol can be produced in large amounts, both by recovering it from processes already in use and by erection of new cracking plants. However, the coke-oven industry currently is producing about 30 million gallons of toluol a year, compared to about 17 million gallons in 1918. This large amount, while not sufficient for the full need, which may amount to from 40 to 60 million gallons a year, already is being produced and not on paper only. At most, the oil industry will be called in to make up the difference and will not replace, in any way, the main source.

Phosphorus in Propellants

Prevention of Corrosion

IN a patent issued to Ernst R. Rechel and Thomas Stevenson of Philadelphia, two U.S. War Department employees, it is revealed that phosphorus will prevent gun-barrels from becoming corroded and pitted. Propellants used in firing shells contain a primer to set off the explosive, the patent explains. On firing, a primer such as potassium chlorate breaks down to potassium chloride and hydrochloric acid. These decomposition products attack the metal, causing it to rust and become pitted, thus tending to impair the accuracy of the weapon. The inventors claim that the addition of from 2 to 10 per cent. phosphorus to the powder eliminates corrosion and pitting. When the powder explodes, the phosphorus is converted into phosphoric acid, which forms a corrosion-resistant coating on the barrel surface of the gun. Guns which had been fired under these conditions and then kept in an atmosphere of 90 per cent. humidity for 1000 hours showed no signs of rusting.

Natural Gas in Ontario*

Methane Utilised in War Industries

THE natural gas industry of Ontario is situated almost entirely in south-western Ontario, in the section extending from Niagara to Windsor, with Lake Erie marking its southern boundary, and Sarnia, London, Galt, Hespeler, and Hamilton its northern boundary. The largest gas-fields border on Lake Erie and appear to be extensions of gas structures paralleling the Appalachian Mountains in the United States.

Natural gas, particularly that found in Ontario, is largely methane. It has a calorific value of about 1050 B.Th.U. per cu. ft., a density of about 0.6 (as compared to air), and requires about 10 volumes of air for its combustion. It is in many ways an ideal fuel for either domestic or industrial use. It is stored in rock formations under high pressures. The initial so-called "rock pressures" in some wells in California have been 6000 lb./sq. in. or higher, and in some of the developments in Ontario, rock pressures of 1200 lb./sq. in. have been encountered. These high rock pressures have been known to blow the drilling tools and the casing high into the air.

Theory of Origin

The origin of natural gas is usually attributed in America to the decomposition of organic slimes in sedimentary formations, but some have argued that it is volcanic in origin and has migrated to its present position in porous limestone and sandstone from lower formations. The chemist may have difficulty in visualising the production of almost pure methane from either an organic slime or a volcanic magma, and also its storage under very high pressure in limestone and sandstone formations for some millions of years, although the capillary pressure of water in dense rock formations may help in the explanation of the latter phenomenon.

However, admitting that natural gas does occur under high pressure in certain limestone and sandstone formations, and that means are available for tapping this supply of fuel, the next question of interest is the problem of estimating the life of a particular well or field. Given the initial rock pressure, the volume of production over a period of time, and the final rock pressure, it should not be difficult to make a reasonably accurate estimate of the gas reserves of a well or field, on the assumption that the volume occupied by the gas underground remained constant. The matter is unfortunately not so simple, since in some wells both bottom and edge water may displace the gas almost as rapidly as it is removed from the porous sandstone or limestone; in others, the back pressure on the well cannot be allowed to fall below a somewhat high value without drowning out the well.

After the gas enters the transmission-line, other interesting phenomena may occur. For instance, with the gas under pressure and containing water vapour, an ice-like substance may be deposited at temperatures as high as 7° C. This consists of hydrates of some of the hydrocarbons, compounds which most chemists would not expect to occur.

As for the actual distribution lines south-western Ontario is provided with an extensive system which carries natural gas, sometimes at pressures as high as 200 lb./sq. in., and sometimes for distances of over 150 miles, from a number of gas-fields, to serve such cities as Sarnia, Windsor, Chatham, London, St. Thomas, Brantford, Hamilton, St. Catharines, etc. The volume of gas produced on a peak day in winter may be 70 million cu. ft. or more; and since its calorific value is roughly twice that of manufactured gas, this output is equivalent to about 140 million cu. ft. of manufactured gas. However, owing to the large house-heating load carried by the natural gas industry, the production on a warm summer day will be only one-fifth of the peak production mentioned above. For purposes of discussion, the gas load of the indus-

try may be divided into normal domestic, house-heating, and industrial loads. The normal domestic and industrial loads are usually quite steady, the heating load depends wholly upon the weather.

The industry is subject to Government regulation and, should a shortage of gas develop, the domestic consumer would be given the preference, the industrial load being sharply curtailed during periods of peak demand. During the summer of 1940, it became evident that one of the natural gas companies would have difficulty in carrying its load this winter during periods of severe cold weather. This situation was caused by a number of factors, including a disappointing drilling campaign during the summer, the early failure of an important field, and an increase in demand caused partly by the war industries going to three shifts and seven-day operation, and increasing their demands in other ways. It was recognised that everything should be done to minimise and, if possible, avoid any interruption in the gas supply to the war industries. To assist in meeting this situation, the Ontario Department of Mines asked the Ontario Research Foundation to make a survey of the industrial use of natural gas.

Industrial Installations

Modern industrial gas installations have reached a high level of efficiency, and there are large furnaces now operating in industry with high efficiency under completely automatic control, and with practically no noise. Through many of these, which are subjected to a closely controlled temperature cycle, parts for munitions travel continuously. One interesting installation is that of a large motor company producing military trucks. Low-pressure gas is compressed to about 25 lb./sq. in., and delivered to over a hundred furnaces, where the pressure of the gas is utilised in inspiring the necessary air for combustion. In another plant of a similar type were drying ovens some 300 ft. long, in which the air was heated by large atmospheric burners, some of which would burn 1000 cu. ft. of gas per hour. In the same plant, natural gas was diluted in an automatic mixing machine, and used to run block tests on engines.

Natural gas is used, not only as a source of heat, but also to provide neutral atmospheres for bright annealing and atmospheres for gas carburising. An interesting installation for the latter purpose is a battery of revolving retorts used for carburising truck chains. Ontario's natural gas industry is undoubtedly making a major contribution to the war effort, and has the advantage over other fuels in that it is not imported and creates no exchange problem. Since the total sales value of natural gas in 1939 was eight million dollars, this is an item of some importance.

The Beattie-Bridgeman Equation

Extended Use Demonstrated

THE Beattie-Bridgeman equation of state for gases is of considerable accuracy when the empirically derived constants are available. Maron and Turnbull (*Ind. Eng. Chem.* 1941, 33, 408-410) have shown that the constants may be calculated with fair accuracy from the critical constants of the gas and the Beattie-Bridgeman constants of a reference gas, and that if these calculated constants are used the equation, while not as accurate as when the empirically derived constants are available, is more accurate than the van der Waals equation except in the region of reduced temperature 1.0 to 1.25. The authors show that for methyl chloride, methane, methyl and ethyl alcohol, ammonia, nitric oxide, hydrogen, oxygen, carbon dioxide, ethylene, ethane, and propane, and using nitrogen as the reference gas, errors are less than 4 per cent. (usually considerably less) outside the region $T_r = 1.0 - 1.25$.

* From a paper presented at the Toronto Branch meeting of the Canadian Institute of Chemistry, February 12, 1941, by Dr. A. E. R. Westman and published by *Canadian Chemistry and Process Industries* (1941, 25, 3, pp. 111-112).

Zein Production and Properties

An Industrial Protein of Diverse Application

Z EIN is the alcohol-soluble protein of corn and is being produced on a commercial scale as a by-product in the processing of corn to starch. Its production and properties have been described by L. C. Swallen, Corn Products Refining Company, Argo, Ill., U.S.A., in *Ind. Eng. Chem.* 1941, 33, 394-398. Early work on isolation of zein was rendered unreliable by denaturation of the protein due to the methods of purification then used; even present methods may cause some denaturation.

Companies processing corn for starch production have further investigated its preparation and properties. In this processing the zein is concentrated in the gluten fraction which contains 50 per cent. or more of protein, of which 70 per cent. is zein. The potential yield is at present about one pound per bushel of corn, but this is dependent on the variety of corn and other conditions. Showalter and Carr (*J.A.C.S.* 1922, 44, 2019-23) have reviewed the literature on its occurrence, and have themselves found that corn contains 8.06-18.43 per cent. total protein, of which 2.21-10.44 per cent. is zein. The author found that the corn he examined contained a maximum of 6.4 per cent. zein.

For its extraction the aliphatic alcohols are most useful, although methanol is unsuitable as it causes denaturation, but ethyl and isopropyl alcohols satisfy all requirements. Extraction curves were obtained based on the extraction of gluten meal of 14-30 mesh and containing 51 per cent. protein on the dry material. These show that the extraction of zein reaches a maximum of 70 per cent. at 60° C. in 55-65 vol. per cent. ethyl alcohol and in 50-60 per cent. isopropyl alcohol, and at 30° C. maxima of 50 per cent. in 67 per cent. ethyl alcohol and of 60 per cent. in 60 vol. per cent. isopropyl alcohol. In each case the concentration includes the moisture in the gluten meal and the extraction refers to a time of five hours. Increase of temperature above 65° C. results in denaturation. From a practical standpoint, since zein appears to consist of at least two chemical substances of different solubility characteristics, it is preferable to use not less than 85 per cent. isopropyl alcohol or 92 per cent. ethyl alcohol so that only the portion readily soluble in alcohols is extracted, the yield being 70 per cent. of the zein content at 60° C. The remainder of the zein is soluble only in weaker alcohol and may eventually be extracted for use in plastics.

Commercial Extraction Process

On the commercial scale the gluten meal is screened to remove the portion less than 40 mesh and is fed into a seven-stage, continuous countercurrent, extraction plant with separation by settling between the stages. Here it is extracted with 85 per cent. aqueous isopropyl alcohol at 55-60° C., the time of contact being 1.5-2.5 hours. The extract is a deep yellow liquid, somewhat viscous, containing about 60 gm. per litre of protein, almost all the oil present to the extent of about 1 per cent. in the gluten meal, the xanthophyll pigments and some water soluble material. The extract is cooled to 15° C. and filtered, the exact conditions of this operation having an important effect on the solubility and stability of the zein. The clear extract is then mixed with 80-120 vol. per cent. of hexane, whereupon two layers separate, the upper containing almost all of the hexane, most of the isopropyl alcohol, not less than 97 per cent. of the oil and 90-95 per cent. of the xanthophyll pigment; the lower layer consists of a 15-20 per cent. zein solution in about 60 vol. per cent. alcohol. The layers are separated in continuous centrifuges and the small amount of hexane in the zein layer is removed by vacuum distillation. The zein is then precipitated by spraying the viscous solution into a rapidly moving body of refrigerated water, and the fibrous brittle product rises to the top of the liquid whence it is

skimmed off by drag paddles to a rotary filter. Drying is complicated by the fact that moist zein becomes a plastic mass above 15° C., but this difficulty is overcome by mixing the filter cake with refrigerated dry powdered zein, then grinding, and feeding the ground mixture into a stream of hot air, when very rapid drying ensues. Careful control of the air temperature and attention to the cleanliness of the system are necessary to avoid denaturation of the zein which, as mentioned later, is an autocatalytic reaction.

The product is a fine, slightly yellow powder containing 7-8 per cent. volatile matter, not more than 2 per cent. non-protein solids, less than 0.5 per cent. each of oil and ash, and is soluble to the extent of 98-99 per cent. in 92 per cent. ethyl alcohol at 25° C. The greater part is of molecular weight about 35,000. The molecule has relatively few active groups; on a mol. weight of 38,000 there appear to be 12 free acidic groups, but these are weak and cannot be neutralised sufficiently to affect the solution of zein below about pH 11.8. There may also be nine free basic groups on the above molecular weight. Zein is more stable to heat than would be expected from the instability of the solution, and may be heated when dry for several hours at 100° C. without affecting its properties; it does not decompose perceptibly even at 200° C.

Avoidance of Denaturation

The solutions are prone to denaturation of the protein resulting in loss of solubility, with precipitation of the decomposition products which catalyse the denaturation to such an extent that gelation may occur in a few hours. The denaturation is also hastened by agitation. It is reduced in solvents of low water content, and in the case of ethyl alcohol the stability is fairly good above 90 per cent. alcohol, but decreases rapidly below this concentration. Complete stability has not been achieved, but addition of certain stabilisers, notably highly acid resins such as rosin, enables 85 per cent. alcohol to be used in practical formulations without undue instability.

The general behaviour towards solvent mixtures is rather similar to that of other high molecular substances such as cellulose nitrate and acetate, etc. Zein is insoluble in anhydrous alcohols (except methanol, in which it is unstable), but is soluble in the presence of some water. Ethylene glycol, diethylene glycol, ethylene glycol ethyl ether, furfuryl alcohol, and tetrahydrofurfuryl alcohol are solvents in the absence of water, as also are acetic and lactic acids and some phenols, although phenol itself requires the presence of a small amount of water or alcohol. Aliphatic amines are solvents but give unstable solutions, while aromatic amines prove satisfactory for this purpose after the addition of a little alcohol. Methyl and ethyl lactates are solvents, but other esters of hydroxy-acids require the addition of small amounts of alcohols or water to effect solution. Ketones require water additions, e.g., acetone is a solvent at between 60 and 80 vol. per cent.

Anhydrous solvent mixtures are important technically since resin and plasticiser additions can then be made which might be incompatible with water. The anhydrous solutions are generally of higher viscosity than aqueous solutions, and addition of small amounts of water to solvent mixtures reduces the viscosity without rendering the mixture incompatible with resins, etc., owing to the water being taken up by the zein.

Zein also dissolves in aqueous solution of pH above 11.5, the alkali requirement being equivalent to 1.2 per cent. NaOH on the zein. Solutions as concentrated as 20 per cent. may be so obtained and applied as coating or impregnating

solutions. The caustic soda, however, reacts with the zein in time, and on this account caustic potash is preferable. Aqueous solutions of soaps, fatty acids, and rosin disperse zein easily, and the resultant solutions may be diluted with considerable amounts of water. Such solutions are especially applicable to coating and impregnation, in view of the saving in volatile solvents so effected.

Zein may be cured with formaldehyde, with which it reacts more slowly than does casein. The product has improved toughness, strength, and water-resistance. For practical purposes it is best to catalyse the reaction by additions of acids, *e.g.*, acetic or lactic, although, where permissible, mineral acids are better.* Small amounts of ammonia or primary amines in the presence of excess of acid act as promoters. The curing is inhibited by alcohols. Formamide may also be used for curing, the amount being generally 30 per cent. of the zein, or 40 per cent. if the film, etc., is not to be hot cured. The formamide is added to the zein solution to be used for coating, but the product tends to become brittle on ageing.

Plasticisers include rosin, manila or shellac, alcohol-soluble ester gum, and dibutyl tartrate, but fatty acids of high molecular weight are preferable. Other plasticisers include diethylene glycol or Carbitol, and glycol phthalate, where water resistance is not important. In certain cases substituted sulphonamides are efficient.

The uses of the material are potentially large. Owing to its slow reaction with formaldehyde, this may be incorporated in the plastic before forming, a method which is more convenient than the prolonged immersion in a formaldehyde bath required by casein products. A plastic may be made by mixing zein* with about 20 per cent. of its weight of water, 5 per cent. of formaldehyde, plasticisers, pigments, etc., and plasticising the mixture on rolls. A partial cure is effected by pressing at about 100° C. for a short time, after which preliminary forming operations such as cutting, punching, or stamping may be carried out. The cure is completed by rather prolonged heating at 60-100° C. The fully cured material may be finished quite readily on automatic cutting machinery, and produces very little wear on the tools. It may also be dyed from aqueous dye-baths

after all forming operations have been completed. Cold-pressure from the powder and curing by immersion in a formaldehyde bath containing catalysts is another method of curing that is especially successful on thin sections with vacuum-pressure treatment in the bath. The products are very tough with a transverse strength of about 15,000 lb./sq. in. Their water resistance is rather better than that of casein products, the equilibrium moisture content being about 10 per cent.

Oil-Resistant Films

The use of zein products in paper coating is suggested, as it gives a very pleasing surface suitable, *e.g.*, for magazine covers, and is notably resistant to scuffing. Suitable compositions contain rosin and are plasticised with fatty acids, and are applied as an alcoholic solution or as an aqueous dispersion. Zein films are outstandingly resistant to penetration by oils and greases, and a very thin film will permit the application of a wax coating to paper without penetration of the paper. They are also effective as sealing coats against penetration by phenolic resins or asphalt, a service for which few materials are available.

Zein is rather too costly for general use as an adhesive, but it may with advantage be used with high-quality veneers, since it does not penetrate the wood, and the joint may be made waterproof by incorporation of formaldehyde. Laminated board can be made using zein-impregnated paper and pressing dry at 100° C. at 500-2000 lb./sq. in. The impregnation of paper is not easy, because of the high molecular weight, but it may be effected by using an absorbent paper and applying the zein in concentrated solution at a slightly raised temperature.

A further use has been found in solid colour printing where the object is to apply a dye coating as evenly as possible to a paper surface. It aids the spread of the dye and avoids the metallic appearance common to the more usual vehicles and caused by the presence of undispersed dye crystals. Fastness to light is also frequently improved and bleeding reduced or prevented.

The production of films and fibres is expected to be an important use, but development is being deferred until more satisfactory methods of curing are known.

Ventilation in the Black-Out

Further Notes on an Important Problem

IN factories ventilated by mechanical installations the wartime lighting restrictions are unlikely to interfere with the ventilation arrangements very much, but difficulty has been experienced in those where reliance is placed on natural ventilation. At the outbreak of war, windows and other openings were hastily blacked out with little thought of ventilation, and in many premises the ventilation was seriously restricted.

In the winter months, even when only a day shift is worked, the period during which lights must be screened is long enough to allow considerable deterioration of atmospheric conditions when ventilation is restricted on account of lighting precautions. Because of the reduced ventilation rate the temperature rises, the humidity increases, and the air movement is reduced—all changes which tend to cause feelings of oppression and to militate against efficient working. In factories where ventilation has been interfered with by black-out arrangements special provision for ventilation is a matter of urgency. Where a night shift is worked, the need for such provision is even more imperative.

Under normal conditions openings for natural ventilation should be of generous size, a useful working rule being to provide at least 5 sq. ft. of ventilation opening for each 100 sq. ft. of floor area. But such openings must be screened during the hours of darkness; and however carefully a "light-trap" for a window or other opening is designed,

it will, as a rule, hinder the flow of air to a considerable extent—possibly by even as much as 50 per cent. Hence for satisfactory natural ventilation under black-out conditions a greater area of ventilation openings is necessary than under normal conditions.

A ready method for providing the needful ventilation is by introducing some mechanical system. This may take the form of extraction fans suitably placed in the external walls or in window frames. With proper arrangements for the admission of fresh air such a scheme should be reasonably good, provided that the workers near the air inlets are not subjected to unpleasant draughts, and that the openings are yet of sufficient size and so placed that a good circulation of air is insured.

Probably a more suitable method, except for rooms with low ceilings, is the use of fans so arranged as to pass fresh air from outside over a hot surface (*e.g.*, a steam radiator or an electrical element) and thence propel it forward into the room. Such fans should be arranged to circulate large volumes of air at a temperature not much above that of the factory. In this way stimulating currents can be set up without giving rise to unpleasant draughts at working level. It can be arranged that the fans either take all their air supply from outside or recirculate a proportion of the air of the factory as desired. (T. Bedford, "Principles of Factory Ventilation and Heating"; *Occ. Psych.*, 1941, 15, 2, 87)

General News

NEW MEMBERS of the Manchester Chamber of Commerce, elected at the April meeting of the Board of Directors, included C. Cussons, Ltd., scientific instrument makers and precision engineers, The Technical Works, Lower Broughton, Manchester, 7.

AN EIRE GOVERNMENT ORDER has been made attaching an open licence provision to the duty on heavy mineral hydrocarbon oil. It has been decided that oil for certain purposes shall be admitted duty free and in order that this may be done a licensing scheme in respect of imports is necessary.

A CHART WAS REPRODUCED in the advertisement on the front cover of *THE CHEMICAL AGE* for April 19 with the intention of showing the close adherence to the set value given by the Kent automatic specific gravity control. That it did not show this precisely was due to a slip in printing register; we have actually seen that the chart shows an excellent result.

THE BOARD OF TRADE ANNOUNCES that Transport and Progressing Officers have now been appointed to most Area Boards to assist the Board of Trade representative in the matter of transport, where particular difficulties have been met with by exporters. A list of names and addresses of the officers appointed is available at the offices of *THE CHEMICAL AGE* and information on the subject will be sent on application.

THOSE AFFECTED by the Business Insurance Scheme under the War Damage Act are reminded by the Board of Trade that the days of grace allowed for taking out policies of insurance end on May 15. Persons who do not insure by that date will be covered only from the date on which applications are received, with premiums. Full information and application forms for insurance are obtainable from fire insurance companies, Lloyds brokers or others carrying on fire insurance agencies.

OCCUPIERS OF FACTORIES and other employers of labour, have been approached by the Government through their representative bodies or associations with a view to the holding of gas mask drills by the staffs of all commercial and industrial establishments. Employers are asked to do all in their power to persuade staffs to bring their respirators to work, and to keep them handy, and also to arrange for periodical practises, so that all may become accustomed not only to putting on their respirators quickly, but to wearing them at work.

ADDRESSING THE MEMBERS of the Bury Rotary Club on Wednesday last week, Dr. Colin Campbell spoke on "What has Chemistry to do with Lancashire?" He reviewed the history of the heavy chemical industry in the county, which started about 1720, when sulphuric acid first came into prominence in the bleaching and dyeing trades; the discovery of chlorine followed about 1785, and the process of making carbonate of soda from common salt, in 1790. The presence of coal and salt in Lancashire and Cheshire had had a profound effect on the Lancastrian chemical industry.

REGIONAL CONTROLLERS of Factory and Storage Premises have been appointed to the Civil Defence regions. They will be: Northern Region (Newcastle-on-Tyne), Mr. T. Muir Wilson; North-Eastern Region (Leeds), Mr. G. E. Naylor; North Midland Region (Nottingham), Mr. G. H. Spencer; Eastern, London, and South-Eastern Region (London), Captain S. J. Graham; Southern Region (Reading), Mr. H. M. Ford; South-Western Region (Bristol), Mr. T. D. Morison; Wales (Cardiff), Mr. R. Walters; North-Western Region (Manchester), Mr. J. Bennett Storey; Scotland (Glasgow), Mr. R. A. Maclean. The Controller of the Midland Region has not yet been appointed.

THE BRITISH COLOUR COUNCIL has issued a résumé of the colours shown on their Autumn and Winter 1941 Wool Card which, owing to enemy action, is the only card ready for release at the moment. Serious delay to industry has been avoided as far as possible by means of advance colour information sent with cuttings or colour swatches. Silk and rayon, millinery, hosiery and leather colours are already available and résumés of these cards will be sent out as soon as issued. Yorkshire dales and moorland, Scotland's hills and glens are described as having inspired the Council's choice of 16 colours for autumn and winter, 1941, designed for yarn-dyed and piece-dyed wools and worsteds, tweeds and mixtures.

From Week to Week

Foreign News

WORKERS IN THE ITALIAN iron and metal industries, states a report from France, are to work twelve hours a day for six days a week under a decree issued in Rome.

A CHEMICAL WARFARE DEPARTMENT has been set up in the Japanese Inspectorate-General of Military Education, it is officially announced in Tokyo.

SOUTHERN RHODESIAN IMPORTS of drugs and chemicals rose from a value of £475,507 in 1939 to £588,724 in 1940. The corresponding export figures were £11,657 and £17,122.

SULPHATHIAZOLE HAS BEEN ADDED to the list of chemicals made in Canada for the purpose of the administration of tariff item 208t. The order to this effect became effective on March 14.

REPORTS FROM PERU indicate that the Santa Barbara mercury mine is being reopened and should be exporting its product within six months. A pilot electrolytic zinc refinery has started operations at Oroya.

CANADIAN INDUSTRIES, LTD., propose to build a \$1,500,000 plant for the manufacture of nylon yarn on a 100-acre site, two miles west of Kingston, Ontario. The work was scheduled to begin in March.

EXTENSIONS TO THE SULPHURIC ACID PLANT of Wallaroo-Mount Lyell Fertilisers, Ltd., at Port Adelaide, Australia, are reaching completion. It is hoped that acid manufacture will begin within the next month.

CHEMICALS, SUCH AS ACETANILIDE, saccharine and nitrocellulose, which Sweden formerly imported are now produced at Bofors in sufficient quantities to meet the country's immediate needs. The Bofors company is attempting to utilise the by-products and raw materials from its normal production to satisfy as many civilian needs as possible.

Forthcoming Events

THE SOUTH YORKSHIRE SECTION of the Institute of Chemistry will hold its annual meeting at Rotherham Technical College on May 5 at 7.30 p.m.

THE EIGHTEENTH ANNUAL GENERAL MEETING of the British Chemical and Dyestuffs Traders' Association will be held at the Great Eastern Hotel (Abercorn Rooms), London, E.C.2, on May 7 at 2.30 p.m.

A MEETING OF THE Society of Public Analysts and Other Analytical Chemists will be held at 5 p.m., on May 7, at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1. The following papers will be read and discussed: "The Determination of Metals by means of 8-Hydroxyquinoline: The Determination of Oxime Precipitates using X-ray Diffraction Methods," by R. C. Chirnside, F.I.C., Celia F. Pritchard, B.Sc., A.I.C., and H. P. Rooksby, B.Sc., F.Inst.P.; "A Semi-micro Method for the Determination of Reichert-Meissl, Polenske, and Kirschner Values in Butter Fat," by Bernard Dyer, D.Sc., F.I.C., George Taylor, F.I.C., and J. Hubert Hamence, M.Sc., Ph.D., F.I.C.; and "The Micro-Analysis of Soft Vulcanised Rubber Products," by G. H. Wyatt, Ph.D., A.I.C.

THE ANNUAL MEETING of the South Wales Section of the Institute of Chemistry will take place on May 8 at the Mackworth Hotel, High Street, Swansea.

DR. R. F. BOWLES has agreed to give a résumé of his thesis on "The Gelation of Linseed Oil Films in the Presence of Cobalt" (which has been published in recent issues of *J. Oil and Colour Chem. Assoc.*) at a meeting of the London Section of the Association to be held at the Federation of British Industries, 21 Tothill Street, London, S.W.1, on May 8, at 6 p.m. The discussion will be opened by Prof. E. K. Rideal, Professor of Colloid Science, Cambridge University, and other speakers who have promised to take part are Dr. L. A. Jordan, Director of the Paint Research Station, Dr. G. L. Riddell, Director of the Printing Ink and Allied Trades Research Association, and Mr. Emil Hatschek.

Personal Notes

MR. DAVID BOYD, director of Doughty Goole Fertilisers, Ltd., has been appointed managing director, the appointment to take effect from the end of June next.

MR. W. A. WOODSON was elected president of the North-East Coast Institution of Engineers and Shipbuilders at the general meeting last week.

MR. C. A. O. RIDEAL has recently been elected a director of May and Baker, Ltd., in succession to the late MR. J. M. FISHER.

MR. L. M. AYCOCK, formerly with F. W. Berk & Co., has joined the sales department of the California Chemical Co., New York. He is to concentrate on selling magnesium oxide to the fertiliser industry.

MAJOR R. W. JENKINS, as a result of a serious fall at the offices of Robert Jenkins and Co., Ltd., Rotherham, on April 15, will be unable to attend to any business for some time to come.

SIR WALROND SINCLAIR, whom the Minister of Supply has appointed to the post of Controller of Rubber, is chairman of the India Rubber Gutta Percha and Telegraph Works Co., Ltd., and of the British Tyre and Rubber Co., Ltd., and is a director of United Glass Bottle Manufacturers, Ltd., among many other well-known companies.

MR. ESSINGTON LEWIS, Director-General of Munitions in the Commonwealth of Australia, has been awarded the medal of the Australasian Institute of Mining and Metallurgy for 1940. This medal, the highest honour that the Institute can confer on a professional man connected with the mining and metallurgical industries, was presented at the Institute's annual meeting at Melbourne University on March 31.

The following were re-appointed at the annual general meeting held on April 23, to serve as the officers of the British Chemical Plant Manufacturers' Association for the ensuing year: Chairman, MR. B. L. BROADBENT (Thomas Broadbent and Sons, Ltd.); vice-chairman, DR. G. E. FOXWELL (Clayton, Son & Co., Ltd.); honorary treasurer, MR. W. S. KNIGHT (Kestner Evaporator and Engineering Co., Ltd.).

DR. C. S. DARWIN, Director of the National Physical Laboratory, has been officially appointed Director of a Central Scientific Office, working under the direction of the British Supply Council in North America. Dr. Darwin's duty will be to collaborate with United States research bodies, to act as a channel for the exchange with the appropriate United States authorities of technical and scientific information, and generally to co-ordinate scientific and technical inquiries.

ALDERMAN J. H. SMITH, once a prominent figure in Widnes chemical industries, has been forced to enter a nursing home for a complete rest. After 55 years' service with the United Alkali Co., he retired some years ago from the position of labour manager to the company's group of works. He began his career in 1875 as a laboratory boy at the Hutchinson works. Distinguishing himself in public life, he became a county alderman, and in 1938 received an honorary degree from Liverpool University.

The following have passed the examination for the Fellowship of the Institute of Chemistry: MR. FRANCIS DUDLEY STEWART BUTEMENT, B.Sc. (in inorganic chemistry, with special reference to the analysis of metals); MR. RONALD ARTHUR REED, B.Sc. (in organic chemistry); and MR. CECIL EDWARD MAURICE GOODRICK, B.Sc., and MISS DOROTHY MARY MATHEWS, B.Sc. (in the chemistry of food and drugs and of water). In addition 20 candidates have passed the examination in general chemistry for the Associateship of the Institute.

OBITUARY

MR. JOSEPH MICHAEL O'BRIEN, who died suddenly in London on April 22, was a director of the Kolok Manufacturing Co., Ltd., makers of carbon papers and ribbons.

DR. LOUIS KAHLENBERG, professor of chemistry at the University of Wisconsin since 1907, died on March 18 in Florida, aged 71.

PROFESSOR JAMES ROBINSON BAILEY, B.A., Ph.D., whose death in Texas on March 25 at the age of 72 is reported, had been professor of chemistry in the University of Texas since 1911. He had worked under von Baeyer in Munich and was awarded his doctor's degree there in 1897. His principal work dealt with the nitrogen compounds, and latterly the nitrogen bases from petroleum in particular.

PROFESSOR CHARLES GILBERT CULLIS, D.Sc., M.Inst.M.M., who died suddenly at Hindhead, Surrey, on April 27, aged 70, was Professor Emeritus (Professor in 1931-36) of Mining Geology in the University of London, and a Past President of the Institute of Mining and Metallurgy. He served also as a member of the non-ferrous metallic ores committee of the Ministry of Supply. One of the world's leading authorities on mineralogy, he had made a special study of the mineral resources of Cyprus.

LETTER TO THE EDITOR

A Bouquet from Australia

SIR,—Your issue of November 2 referred to production of your paper in a fantastic environment and under unprecedented conditions.

Although I have read every issue of your journal for the past eighteen years, I did not detect any difference which might suggest a misadventure.

Permit me to offer my congratulations on the marvellous way THE CHEMICAL AGE, together with the other technical press of Great Britain, is carrying on its invaluable work in circumstances which we fortunate people in Australia can scarcely realise.—Yours faithfully,

LEONARD CERUTTY.

c/o Electrolytic Zinc Co., Ltd.,
Hobart, Tasmania.

February 6, 1941.

British Chemical Prices

Market Reports

A STEADY flow of business is reported in most sections of the general chemical market and new bookings during the week have been on moderate lines and are largely concerned with early delivery dates. Prices continue firm at about previous figures, there being no outstanding advances to record. In the potash section yellow prussiate of potash supplies continue on the short side and there is a persistent demand for available parcels of caustic potash. Nearly all the soda products continue in regular request and offers of yellow prussiate and bichromate are quickly absorbed. Trade in coal tar products continues on the active side, the demand being well spread over most items. Values throughout this section are steady and a firmer tendency is noted.

MANCHESTER.—Although actual price movements on the Manchester chemical market during the past week have been few, virtually the entire range of "heavies" is on a very firm basis, whilst a strong tendency continues in most of the tar products. The alkalis and other leading heavy chemicals this week have attracted moderate attention so far as new business is concerned, and there has been little falling off from recent levels in the rate, at which supplies are being taken up against orders already on the books of sellers. Dyeing and finishing chemicals are in fair demand. A steady trade is passing in the bulk of the tar products and the recent advances in this section have been well held.

GLASGOW.—Business in the Scottish heavy chemical trade has maintained the slight improvement reported last week for home trade. Export business remains quiet. Prices still keep very firm.

Price Changes

Hydrochloric Acid.—Spot, 6s. 3½d. to 8s. 9½d. carboy d/d, according to purity, strength and locality.

Nitric Acid.—£23 to £31 per ton ex works.

Sodium Carbonate Monohydrate.—£21 per ton d/d in minimum ton lots in 2-cwt. free bags.

Tartaric Acid.—3s. 0½d. per lb., less 5% carriage paid, for lots of 5 cwt. and upwards. MANCHESTER: 3s. 0½d. per lb.

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Metallurgical Section

May 3, 1941

POWDER METALLURGY

A Field for New Developments

by FREDERIC NEURATH, Ph.D.

THE technique of forming solid objects from metal powder is of comparatively recent development, and the subject, during the last few years, has acquired an industrial significance with important possibilities. Most of the widely dispersed publications concerning it are in the German and Russian languages. The principle consists in welding (for massive metals) or sintering (for metal powders) by pressing them at high temperatures, when recrystallisation and grain growth are obtained. As is well known, the melting point of solid substances is lowered by increasing pressure locally. The effect is influenced by different circumstances, such as particle size and shape, pressure and its method of application, temperature, and whether the process is applied under vacuum or in a hydrogen atmosphere and subject to special sintering forces.

The different methods and details vary with the characteristics of the metals concerned, notably with their plasticity and with particle size and shape, upon which the area of contact depends. The compacts must be protected from oxidation, as oxide films reduce the area of contact, and therefore the high-temperature operations are maintained in a neutral or reducing atmosphere, usually in hydrogen or partly burned gas, but sometimes in a liquefied gas and often under pressure.

The basic experiments on powder metallurgy were made by F. Sauerwald and co-workers and by W. Trzebiatowski, and were collected and summarised by W. D. Jones in the book *Principles of Powder Metallurgy* (London, 1937). An investigation limited to copper was recently published by C. G. Goetzel (*J. Inst. Met.*, 1940, 66, pp. 319-329).

There is no space here to deal with the details of the raw materials, but some industrial applications may be of special interest.

Initial Processes for Metal Powders

The methods of making the initial metal powders are no doubt fairly generally known. They are either deposition from a gas, carbonyl powders (mainly for iron, nickel and their alloys), or electrolytic products, as for copper. Mechanical methods of comminution, pulverising, grinding, and stamping are mostly applied for pigments and seldom for sintering. Other methods include chemical reduction at temperature below the melting point, used in the case of tungsten, molybdenum and copper; precipitation and atomisation, for tin powder; and distillation and condensation, for zinc.

As to the carbonyl processes it may be recalled that they are derived from a chance discovery, made in 1888, in the laboratory of the late Dr. Ludwig Mond. It appeared that some valves made of nickel, used in Mond's process for the decomposition of ammonium chloride by distillation, became leaky through the formation of a black crust. Dr. Carl Langer, who was assisting Dr. Mond, made an examination of this crust and found that it contained carbon, derived from the small proportion of carbon monoxide present in the carbon dioxide used to clear ammonia from the apparatus. A further study of this phenomenon led to the surprising discovery that at ordinary temperatures nickel unites with carbon monoxide with comparative ease, the resulting com-

pound being a gaseous product, $\text{Ni}(\text{CO})_4$, now known as nickel carbonyl. It was also found that other metals had nothing like the same affinity for carbon monoxide, and this, coupled with the discovery that nickel carbonyl is easily decomposed into nickel and carbon monoxide at temperatures about 180°C ., suggested to Mond the possibility of using the reactions as a means of refining nickel.

After a great deal of experimental work a successful commercial apparatus was evolved for this purpose, and at the beginning of this century operations on a large scale were started by the Mond Nickel Company, Ltd., at Clydach, near Swansea. Although numerous improvements and extensions have been effected during recent years, the essential process remains the same as when the works were built. Briefly stated, it consists in reducing the nickel oxide in the calcined material to a metallic form (though still contaminated with other elements), treating this with carbon monoxide to form pure nickel carbonyl, and subsequently decomposing this volatile product into pure nickel and carbon monoxide.

Carbonyl Powders

Carbonyl iron powder, being of great purity apart from its carbon and oxygen contents, is a highly suitable material for sintering purposes in the preparation of pure iron or unalloyed steels. Its products show many improved properties as compared with the commercially melted iron and steels. Applications of these products include moulds, porous iron products, e.g., accumulator plates, filter bodies for gases or liquids, fillers for liquid materials, plasters, lamp wicks, safety devices on gas burners, etc. There are many ways of obtaining very porous iron products, the great majority of these making use either of non-metallic materials removed by volatilisation during sintering, or of oxides, which are reduced to metal after sintering. To improve the properties of steels, small amounts of certain metals are sometimes added (stainless steels).

Nickel from carbonyl nickel powder has the advantage of very high purity, of a lower melting point ($1000-1200^\circ\text{C}$.), less wastage, slagging and casting losses and topping of ingots being avoided. It is excellent for the manufacture of the finest nickel wires for the use in radio valves, X-Ray tubes, spark tips, etc. Nickel-iron alloys from the powder process are chiefly interesting because of their magnetic and electrical properties.

Compressed powdered molybdenum-permalloy for high quality inductance coils as manufactured by the Western Electric Company is composed as follows: nickel, 81 per cent.; molybdenum, 2 per cent.; iron, 17 per cent. The raw materials and the necessary embrittling agents are melted and cast into ingots, which are rolled to develop the desired grain structure. The material is then pulverised and finally annealed, to soften the particles before insulation and pressing to core form.

Bronzes for the so-called "oil-less" bronze bearings are produced from sintered copper and tin powders. The resulting compact is exceedingly porous and may be impregnated with oil. Such bearings have shown outstanding advantages in certain directions, and their field of application has

widened very much during the last few years. They are favoured for motor-cars with their many bearings, and for miscellaneous plant where splashing of oil is to be avoided, such as laundry and textile machinery.

Another important application of the sintering process is for the manufacture of hard metal cutting alloys, chief of these being tungsten carbide with cobalt, tantalum carbide with tungsten, nickel and titanium, and molybdenum carbides with nickel. These alloys possess hardness approaching that of the diamond, and are used with the addition of ductile metals as binders and also in conjunction with diamond dust. A great variety of hard cutting materials has been developed, including lapping and drilling tools, grinding surfaces, wheel dressers and wheels for grinding, cutting, shaping, polishing, etc.

Bronze and aluminium powders as a basis for coloured varnish are produced also by stamping of thin bronze, tombac (89 per cent. copper, 5.5 per cent. zinc, 5.5 per cent. tin), or aluminium sheet scrap in a special plant. The stamping is done at a high temperature and, in the case of aluminium (because of the explosion danger), under special precautions. These powders serve as pigments in organic coatings, mostly for rust prevention, using in this process linseed oil, wood oil (for smoke-resisting coatings), benzyl cellulose (for acid-resisting coatings), or chlorinated rubber solution. For rust-protecting coatings for structural steel, silicon carbide powder as a colouring agent has been suggested.

Another process for covering various articles with metal powder is the Schoop process; the metals to be sprayed are first melted in a spray pistol either electrically or by gas and then sprayed on to the objects by means of compressed air. All metals with a melting point not higher than for copper (1050° C.) can be used for this process. Metal powders can also be used for cement coating; the articles to be coated, together with a suitable adhesive, e.g., ammonium chloride, are placed into revolving drums and there brought to higher temperatures. Other ways of powder metallisation are Gerard's process (for zinc on iron) and various processes for obtaining aluminium coatings.

The possible applications of powder metallurgy have not yet been fully appreciated, but considerable developments may be expected, and undoubtedly this aspect of metallurgy will take an important and prominent place in the general working up of metals.

Bearings with Improved Properties

A Development of Powder Metallurgy

AN important new application of the technique of powder metallurgy is outlined in *Inco News*, 1940, 17, 3, pp. 18-20. This development is the production of a new type of precision bearing, and is the joint work of engineers of the Buick and Moraine Products Division of General Motors Corporation, in collaboration with General Motors Research Laboratories.

The bearing, which is designed to withstand extreme operating conditions of high compression ratios, greatly increased power output, higher crankshaft speeds and piston pressures, and resistance to oil corrosion, consists essentially of a thin layer of high-lead babbitt (about 92 per cent. lead with added tin and antimony) bonded to a steel back by means of an intermediate layer of sintered nickel and copper powder in approximate percentages of 40 and 60 respectively. In the process a porous matrix is formed by heating a mixture of nickel and copper powders of the above percentages in a controlled atmosphere to sinter the powders and bond them to the steel backing strip.

Research indicated that if it were possible to bond an extremely thin layer of babbitt securely to a steel back, a bearing surface could be obtained which would have unusual lasting properties and resistance to scoring and wear. The thinner the layer of babbitt can be made and still provide the re-

quired bearing surface, the higher is the efficiency of the bearing. Heavier layers of high-lead babbitts tend to crack and fail under continuous heavy loads.

The sintered matrix which made the new bearing possible is produced under carefully controlled conditions to provide a porous material of high strength. The copper and nickel powders, carefully mixed, are spread on the steel base and sintered at high temperature in a controlled atmosphere, then rolled under pressures up to 10,000 lb./sq. in., a pressure five times the maximum load to which the bearing might be subjected in the most severe service it is apt to encounter.

In production, the bearings, which have been given the name of "Durex No. 100," pass through three separate stages. The first is concerned with the preparation and sintering of the matrix on to the steel in a continuous furnace at 1090° C. The second is the application of the babbitt, and the third is the cutting, forming, and finishing of the completed bearing shells in half-circles. The sintering and rolling operations consolidate the metal powder matrix, provide it with uniform thickness, and bond it permanently and tightly to the steel base by a metallurgical bond having high thermal conductivity. The babbitt is applied in a vacuum tunnel which evacuates all the air from the porous voids of the matrix and permits the babbitt to impregnate and become an integral part of the spongy matrix structure.

The molten babbitt is "frozen" to proper grain size by rapid chilling in water. Thus it is in the closely controlled porosity of the matrix that largely lies the secret of the successful development of the bearings; by means of this matrix, it is possible to use a layer of babbitt only 1/1000 to 3/1000 inch in thickness. The expected life of the bearings is claimed to be more than 200 per cent. longer than that of most conventional type bearings in automotive use at the present time.

Nickel powder was chosen because this metal readily mixes with copper to form a matrix structure of suitable "texture." Furthermore, the nickel imparts a higher degree of strength to the matrix than could be obtained by the use of copper powder alone. Another feature of the alloy matrix lies in the fact that it has sufficient score resistance to support a journal, should failure in the very thin babbitt layer occur as a result of interruption in the oil supply or for similar cause.

Plastic Iron

Research In Powder Metallurgy

AMONG the researches recorded in the 28th annual report of the director to the trustees of the Mellon Institute is included the work done on plastic iron technology by the holders of the multiple fellowship of Plastic Metals, Inc., Johnstown, Pennsylvania (J. L. Young, senior fellow), in developing and perfecting equipment for the production of electrolytic iron powder and melting stock. Owing to its purity, this plastic iron has unusual electrical properties. In powder form it is suitable for the fabrication of magnets, radio cores, and other electrical appliances.

Principally because of the nature of the moulding and sintering techniques employed in powder or ceramic metallurgy, uniformity of quality of the powders used is of paramount importance. The new iron is exceptionally uniform in density, compressibility, shrinkage upon sintering, and other physical properties requisite in compacting and heat-treating iron powder for the production of machine parts. In sheet form the iron has proved useful as melting stock for spectroscopic standards and high-quality ferrous alloys which demand extremely close control of all constituent elements.

The manufacture of this iron involves the reduction of ore into sponge iron, which is then formed into anodes for the electro-deposition process. In the donor's factory, plant has been constructed for unit operation; expansion of capacity therefore will simply consist of providing additional units as required.

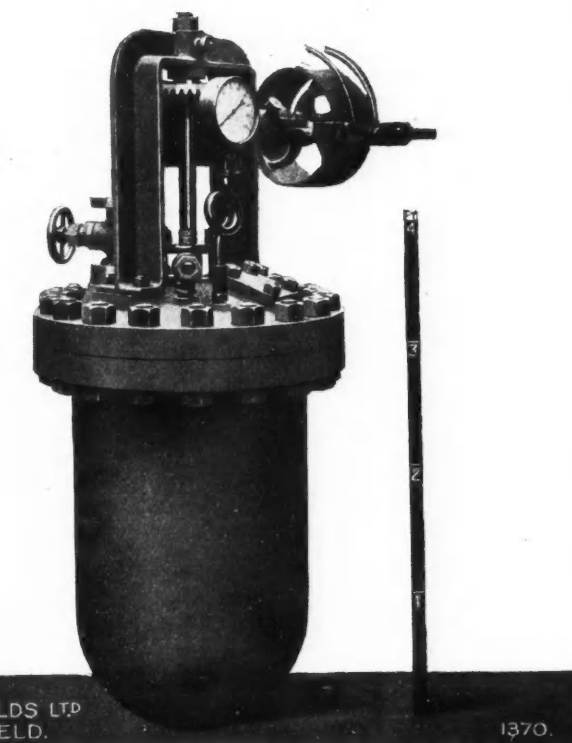
Steels of High Creep Strength

Available for Temperatures up to 550°C

DURING the last few years the operating temperature of many industrial processes has increased enormously and in many instances has reached a point where ordinary steels and other materials of construction can be no longer used. The reason for this is that, at temperatures of above about 350° C. steel behaves in a viscous rather than elastic manner and yields continuously to applied stresses. The elastic limit, yield point and maximum stress are no longer well defined properties, but depend on the applied stress and the rate of loading, and they cannot, in fact, be used for purposes of design where sustained loads have to be borne.

Under such conditions, therefore, calculations must be based on the continuous deformation produced by a sustained load over a long period, which is known as "creep," this being defined as the stress which will produce a certain rate of deformation, or creep, at a certain temperature. It has been found that certain elements, notably molybdenum, greatly increase the creep strength of steel up to a maximum temperature of 550° C., and the steels described in this article have been designed to work within this temperature range. All are characterised by high creep strength and are immune from or exhibit no practical tendency to embrittlement after prolonged heating at elevated temperatures, but they differ with respect to their properties at ordinary temperatures.

The use of creep-resisting steels is indicated in high-temperature chemical plant such as autoclaves, reaction chambers for synthesis and hydrogenation and in valves and piping. MESSRS. HADFIELD'S, LTD., Sheffield, in their new booklet No. 446, have described their creep-resisting steels of carbon-molybdenum and chromium-molybdenum composition. The former are mild steels and are listed as "Era 131," which has the highest creep strength in this class, and "Era 131B." The Cr-Mo steels are characterised by a high tensile strength at ordinary temperatures and are particularly useful for autoclave bodies. The chromium present increases the strength of these steels in the cold after heat treatment, and enhances their



Autoclave of Hadfield's "Era 131" heat-resisting steel; 20 gallons capacity

resistance to the attack of sulphur compounds, to oxidation and to hydrogen fissure. "Hecla 153" is a steel of this type, extensively used for autoclave bodies, with good resistance to scale. "Era 147" is used in the manufacture of reaction vessels, notably for oil-refining and cracking plant. The booklet mentioned contains full particulars of all these types of steel and gives special instructions to be observed when welding is undertaken.

At temperatures above 650° C., resistance to scaling becomes increasingly important, and more highly alloyed heat-resisting steels are called for. At these temperatures, moreover, the steels dealt with in this catalogue no longer maintain their high creep strength, and austenitic heat-resisting steels must be used.

Iron and Steel Movements

U.K. the Largest Purchaser of U.S. Exports

TOTALLING 653,798 gross tons and valued at \$39,691,003, exports of iron and steel products (scrap excepted) from the United States in January, 1941, were at their lowest level for any month since June, 1940, according to figures published in *Foreign Commerce Weekly*. Exports in December, 1940, aggregated 735,178 tons valued at \$44,259,176.

Reflecting application of the provisions of the export licensing programme to the majority of the classes of iron and steel included in the above figures, exports to all Continental areas other than Europe were smaller in January than in December. The countries of North and Central America and the West Indies received 92,165 tons of American iron and steel against 108,639 tons in December; shipments to South America dropped to 24,907 from 66,163 tons; trade with the Far East amounted to 49,123 tons against 153,225 tons; while Africa received 25,466 tons against the 33,909-ton trade of the preceding month. Only Europe—462,137 against 373,242 tons—received more steel in January than in December.

The United Kingdom continued to be the largest individual market for American iron and steel, taking 458,763 tons in January against 362,366 tons in December. Prominent items included in the total were non-alloy steel ingots and blooms, 193,915 tons; pig iron, 76,834 tons; alloy steel ingots and blooms, 53,033 tons; and 26,704 tons of non-alloy "other" plates. Second place went to Canada with takings totalling 69,197 tons, including 16,881 tons of non-alloy black steel sheets, 9914 tons of non-alloy "other" plates, and 7492 tons of non-alloy steel ingots and blooms. Other leading markets in the January trade were the Union of South Africa, the Netherlands Indies, Brazil, and Iran.

United States exports of scrap likewise declined from 69,980 tons in December to 45,055 in January. Here, again, the United Kingdom was the chief purchaser, with 38,776 gross tons. Of the total of 45,055 gross tons of metal scrap, iron and steel scrap accounted for 43,467.

Imports of iron and steel into the U.S.A. in January amounted to only 406 gross tons valued at \$157,284—a new low record. Of this total, 226 tons came from Sweden, 99 tons from the U.K., and 60 tons from Canada.

Alunite as a Raw Material

Possibilities of Aluminium and Potash Production

THE mineral alunite is usually white but often has a greyish or pinkish tinge; it has conchoidal to uneven fracture, is often splintery when massive and sometimes earthy. It frequently has a pearly lustre and ranges from 3.5 to 4 in the Moh's hardness scale. Chemically, alunite is represented by the formula $K_2O \cdot 3Al_2O_3 \cdot 4SO_3 \cdot 6H_2O$. Proportionately, 100 lb. of pure alunite will contain 11.4 lb. K_2O , 37.0 lb. Al_2O_3 , 38.6 lb. SO_3 , and 13.0 lb. H_2O . Enough of the SO_3 radical is present to satisfy the K_2O , forming K_2SO_4 , but only enough SO_3 remains to satisfy one-third of the Al_2O_3 present, forming $Al_2(SO_4)_3$; hence, the exact composition is complex. Theoretically, 53 per cent. of the alumina present represents the metallic aluminium content, but for practical purposes it is customary to calculate 50 per cent. as aluminium.

It is doubtful whether more than 80 per cent. of the alumina in alunite can be recovered because of the usual mechanical and operating losses resulting from chemical processes. On this basis, each 37 lb. of alumina represents roughly 30 lb. recoverable or 15 lb. of metallic aluminium. As the products desired are K_2SO_4 and Al_2O_3 , the excess SO_3 can be driven off and recovered as H_2SO_4 and reused in treating more alunite, as is proposed in several patented acid processes. The mineral thus contains two marketable products and a reagent that can be used in recovering them.

As found in natural deposits, the K_2O content frequently is partly replaced by Na_2O . When this replacement has occurred to the point where the soda content is greater than the potash, the mineral is called natro-alunite. The relative percentages of potash and soda occur over a wide range, but 100 per cent. of the one with none of the other is extremely rare. Whenever the K_2O has been appreciably replaced in the rock by Na_2O , the recovery of K_2SO_4 in a pure state becomes more complicated as the relative proportion of Na_2O increases; hence, the value of K_2SO_4 as a marketable by-product decreases as the alunite approaches a natro-alunite in content.

Alunite occurs in two distinctly different types of deposits—fissure veins and replacement deposits.

As a result of the shortage of potash experienced in the United States during the last war, the alunite deposits of the Western States were among the raw materials used, as a domestic potash source. After the war, however, producers from these fields were unable to compete with imports on post-war price levels, and the deposits ceased to be worked. Since that time alunite has none the less continued to hold the interest of investigators, but principally as a source of alumina for the manufacture of metallic aluminium, the potash content to be regarded as the source of a by-product, thus reversing the original concept. The advance in the development of water-power since the last war has further encouraged investigation, as the manufacture of metallic aluminium requires a considerable quantity of electric power.

Alunite Sources in the Western States

Earlier investigations, dating from 1932, covered only certain deposits in Utah, but now a full report of the resources in the Western States has been made by J. R. Thoenen, supervising engineer, Non-Metal Mining Section, Mining Division, and the results have been published by the U.S. Bureau of Mines (R.I. 3561). Sites in Arizona, Colorado, Nevada, Utah, and Washington were prospected in autumn last year. As regards quantity, seven locations in Piute County, Utah, provided deposits in which the calculated equivalent of pure alunite varied in amount from $\frac{3}{4}$ million to $1\frac{1}{4}$ million tons, only one other location, in Dolores County, Colorado, with just over a million tons, approaching these figures.

No attempt was made to ascertain the best available grade of rock on any property. In fact, in most instances the samples were taken with the idea of obtaining an average grade over a wide, minable area. It was recognised that, to be available, the alunite must lend itself to comparatively

cheap mining practice, which means mass production. In fact, the lower the grade of rock the larger the quantity that must be mined to produce a ton of alunite. In consequence, the analyses of the author's field samples in many instances show a lower percentage of alunite than is given in analyses reported by others for comparison.

Up to the present, alunite has not been utilised on a commercial scale in the United States as a raw material for metallic aluminium. It is true that various investigators report the production of aluminium from alunite in laboratory or pilot plants, but so far the acid test of commercial-scale production has not been applied. In consequence, there is no criterion available to establish the low point in the percentage of alunite present in the rock at which economic utilisation is possible. Some investigators have expressed the opinion that rock containing 50 per cent. alunite can be utilised; others estimate as low as 30 per cent. Hence, as it has not been definitely shown that alunite can be used economically for production of aluminium, the rock containing alunite cannot be defined as an ore. It follows, therefore, that a minimum grade of "ore" cannot be established.

Reserves Available

Any estimate of the total alunite reserves of the United States must be based upon the grade of the rock or the percentage of alunite contained. From the field study made last year, the author's estimate of total reserves is: at 30 per cent. minimum alunite content, 21,909,600 tons of rock and 9,432,775 tons of alunite; at 50 per cent. minimum alunite content, 3,347,330 tons of rock and 2,377,475 tons of alunite. If all other sources of raw material for the production of metallic aluminium were cut off and the national consumption of the metal at the estimated 1942 rate depended entirely on alunite, the reserves would be sufficient for 3.4 years at 30 per cent. minimum alunite content or 10 months at 50 per cent. minimum alunite content. Large deposits of bauxite, however, are known to be available in the United States, and it is inconceivable that the nation should suddenly have to revert to alunite.

A study of the analyses shows that wherever a complete analysis of the alunite has been made, soda is always present, and in at least five deposits the soda content is greater than the potash and these should therefore be classed as natro-alunite deposits. The analyses show further that, whereas pure alunite contains 11.4 per cent. K_2O , or potash, only one shows a potash content of 10 per cent. or better, and outside the vein deposits the potash content is much lower.

As one of the objectives in the use of alunite for aluminium manufacture is the recovery and sale of the K_2O content for fertiliser purposes, it seems, from the analyses, rather doubtful if much revenue could be realised: first, because of the apparently low potash content, and secondly because of the difficulty of separating the soda from the potash.

A NOTE ON METALLOGRAPHY

Photography of the macrostructure of a metal, *i.e.*, the structure as seen by the eye, not only helps in the selection of significant areas for photo-micrography, but provides a record of markings indicative of unsoundness, cracking, segregation, and other faults. The distribution of particles of sulphide in steel provides a clue to the process of crystallisation and can be recorded on the photographic emulsion without the use of a camera, simply by placing a sheet of bromide paper soaked in dilute sulphuric acid in contact with the polished surface of the specimen. Hydrogen sulphide is liberated locally by reaction between the sulphides and acid, and this in turn reacts with the silver halide in the photographic paper, forming a dark silver sulphide image.—(*Photogr. J.*, 1941, 81, 164).

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

EXEAU PRODUCTS, LTD., Enfield, paint manufacturers. (M. 3/5/41). March 28, two mortgages for further securing a debenture dated February 19, 1937, to Special Areas Reconstruction Association, Ltd.; charged on land, factory, etc., at Team Valley Estate and 680 Cambridge Arterial Road, Enfield, with fixed plant, etc. *£7500. March 20, 1940.

Company News

The British Benzol and Coal Distillation Co., Ltd., have declared an ordinary interim dividend of 5 per cent. (same).

The British Match Corporation, Ltd., has declared a final ordinary dividend of 5½ per cent., making 8 per cent. for the year ended April 30 (7½ per cent.). Net profits were £391,566 (£151,269).

Goodlass Wall and Lead Industries, Ltd., have declared a dividend of 6 per cent. on ordinary shares, as last year, but without the 1 per cent. bonus which was paid in 1936-39 inclusive.

The firm of **Robert Liston & Company**, oil and grease manufacturers, Glasgow, has been dissolved on the death of Robert Liston, junior partner. The business will be carried on under the same name by the remaining partner, John Liston.

Timothy Whites & Taylors, Ltd., announce a second interim of 2½ per cent., less tax, on ordinary shares, making 30 per cent. for the year ended December 28, 1940 (same). It is not proposed to recommend any further dividend in respect of that year.

Aberdeen Lime Co., founded in 1837, and the **Northern Agricultural Co.**, founded in 1854, joined forces in 1930 and have since carried on business jointly. A few months ago, as the object of carrying on The Northern Agricultural Co. under its own name had been fulfilled, that company went into voluntary liquidation. The shareholders of the Lime Company were anxious to continue the name "Northern," and at a recent meeting a resolution was passed to change the name into "The Northern Agricultural and Lime Company, Ltd." Sanction for the alteration has now been received.

New Companies Registered

Delmoy Laboratories, Ltd. (366,359).—Private company. Capital £100 in 100 shares of £1 each. Manufacturers of and dealers in chemical intermediaries, compositions and derivatives, disinfectants, laboratory equipment, etc. Directors: J. J. Jenkins and R. J. L. Jenkins, 33 Moy Road, Aberfen, Glamorgan.

Iodised Minerals, Ltd. (366,491).—Private company. Capital £1000 in 1000 shares of £1 each. To acquire the business of manufacturers of iodised mineral cattle foods carried on by Francis Irving, Edward G. Spencer and Horace C. Anson, at Skipton, as "T. L. Irving." Directors: Francis Irving; James S. Heaton. Registered office: 81 Gargrave Road, Skipton-in-Craven.

George Yager, Ltd. (366,587).—Private company. Capital, £500 in 500 shares of £1 each. Manufacturers of and dealers in chemicals, drugs, medicines, plasters, disinfectants, fertilisers, oils, colours, glues, dyes, etc. Directors: Francis H. Cook, Charles A. Colmore, George Yager. Registered office: 698 High Road, Chiswick, W.4.

Plastiglass Ltd. (366,622).—Private company. Capital: £5000 in 20,000 shares of 5s. each. Manufacturers of and dealers in plastic products, plastic powders, glass, refractory materials, chemicals, synthetic materials, cellulose, etc. Directors: Stanley F. Hand; Cyril D. Warr. Registered office: Imperial House, Harley Place, Clifton, Bristol 8.

Chemical and Allied Stocks and Shares

AIDED by the Prime Minister's speech, steady conditions have prevailed in the stock and share markets, although the volume of business was extremely limited, awaiting the next developments in the present phase of the war. Gilt-edged securities, however, showed an upward trend under the influence of the repayment of the L.C.C. 5 per cent. stock and the forthcoming requisitioning of further American dollar securities, which are regarded as foreshadowing a considerable volume of reinvestment into British

Funds. Ordinary or equity shares of industrial companies were in a state of inactivity, and were little changed on balance.

Steadiness was shown in Imperial Chemical around 29s. 3d., while the 7 per cent. preference units were 33s. 6d., awaiting the full results and annual review of the chairman. Borax Consolidated continued firm and were 28s. 6d., while shares of other companies with interests in America were inclined to improve. The units of the Distillers Co. were better at 62s. 9d., while Dunlop Rubber were 32s. 3d. Lever & Unilever, however, eased to 20s. 6d., although the company's various classes of preference shares were virtually the same as a week ago. Turner & Newall were 67s. 6d.; general expectations are that the interim dividend, due in June, will be maintained at 3½ per cent. On the other hand, British Oxygen had an easier appearance at 63s. 1½d., but in other directions, Murex, Metal Box, and British Aluminium were well maintained in price. Goodlass Wall eased to 9s. 6d. on the 6 per cent. dividend, which compares with the 7 per cent. distributed on these 10s. shares in the previous year; no doubt a much increased sum has been provided for taxation. Indestructible Paint at 78s. 9d., and Pinchin Johnson 10s. shares at 17s. were around the lower prices recorded following the recent announcement of the reduced dividends. Particularly in cases where the E.P.T. standard is unfavourable, the market is prepared for lower dividends from numerous companies, but in many instances it would appear that this is already discounted in share prices, and very little selling has been reported this week. It is realised, however, that the trend of values on the Stock Exchange will continue to be governed mainly by the nature of the war news. Boots Drug were little changed at 35s. 3d., and Cerebos and Reckitt & Sons shares were inclined to respond to hopes that the forthcoming results may show dividends at the same rates as for the previous year. Fison Packard have changed hands at slightly over 31s., and elsewhere, pending the results for the past year's working, British Drug Houses transferred at 22s. 10½d. British Glues 4s. shares were firm at close on 6s. on hopes that the announcement, due in June, may show the maintenance of the dividend at 10 per cent., in which case the 8 per cent. participating preference shares would again receive an additional payment of 1 per cent.

Associated Cement were steady at 48s. 9d., while Tunnel Cement 10s. shares were 32s. 6d., at which the yield is 6½ per cent. on the basis of last year's 20 per cent. dividend. British Plaster Board 5s. shares remained fairly active around 13s. 3d., aided by the favourable dividend estimates current in the market. On the other hand, General Refractories were easier at 8s. 1½d. Very small movements were shown in iron and steel securities; Tube Investments were firmer at 89s. 9d. awaiting the interim dividend announcement, and United Steel were 21s. 6d. In other directions, Barry & Staines were steady at 26s. 3d. pending the past year's results, as were British Match at 30s. There were few movements among textile securities, and Courtaulds were 29s. Elsewhere, Beechams Pills 2s. 6d. deferred shares, although "ex" the final dividend, were maintained at around 8s. on satisfaction with the past year's distribution. The 10 per cent. cumulative preferred shares of the last-named company made the better price of 32s. Among oil shares there was again a reactionary tendency under the lead of Anglo-Iranian and Burmah Oil.

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